



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|---------------------|------------------|
| 10/816,958 | 04/05/2004 | Yukio Takigawa | 042323 | 2429 |
| 38834 | 7590 | 07/19/2005 | EXAMINER | |
| WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP 1250 CONNECTICUT AVENUE, NW SUITE 700 WASHINGTON, DC 20036 | | | LE, DUNG ANH | |
| | | | ART UNIT | PAPER NUMBER |
| | | | 2818 | |

DATE MAILED: 07/19/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|-----------------|-----------------|--|
| Office Action Summary | Application No. | Applicant(s) | |
| | 10/816,958 | TAKIGAWA ET AL. | |
| | Examiner | Art Unit | |
| | DUNG A. LE | 2818 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-15 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 05 April 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date ____ | 6) <input type="checkbox"/> Other: ____ |

DL

DETAILED ACTION

Oath/Declaration

The oath/declaration filed on 4/5/2004 is acceptable.

Information Disclosure Statement

This office acknowledges of the following items from the Applicant:

Information Disclosure Statement (IDS) filed on 6/14/2004 and made of record.

The references cited on the PTOL 1449 form have been considered.

Specification

The specification has been checked to the extent necessary to determine the presence of all possible minor errors. However, the applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

Art Unit: 2818

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 7 are rejected under 35 USC 102 (e) as being anticipated by Nabeya et al. (2004/0129569 A1).

Nabeya et al. teach a method for fabricating a semiconductor device comprising the steps of:
forming (figs. 1A-1C, [0006]- [0007]) an opening in an insulation film 2;
forming an interconnection layer of Cu 6 as a main material in the opening 4; and
concurrently injecting nitrogen gas and water to the surface of the interconnection layer buried in the opening (in [0307] and 4th line from bottom).

Regarding claim 7, in the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed (fig. 1).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention

Art Unit: 2818

was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 2, 5, 6, 8, 9, 12 and 13 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Nabeya et al. (2004/0129569 A1) in view of Ngo et al. (6,146,988).

Regarding claim 2, Nabeya et al. disclose the claimed invention as applied to claim 1, except for the step of forming a diffusion preventing film for preventing the diffusion of the Cu on the insulation film and the interconnection layer.

Ngo et al. teach the step of forming a diffusion preventing film for preventing the diffusion of the Cu on the insulation film and the interconnection layer (col 6, lines 40-50).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to form a diffusion preventing film for preventing the diffusion of the Cu on the insulation film and the interconnection layer in Nabeya's method, in order to prevent in-line Cu diffusion between closely spaced apart, thereby preventing shorting and, hence, improving the overall reliability and lifetime of the resulting semiconductor device (col 6, line 55- 60).

Regarding claim 3, the diffusion preventing film is an SiC film or a silicon nitride film (Ngo, col 6, line 48-55).

Regarding claim 8, in the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed (Nabeya, fig. 1).

Regarding claim 12, Nabeya in view of Ngo disclose the claimed invention as applied to claims 1- 2, except for the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water, because it is commonly used to prevent undesirable reactions in the contact region, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the suitable application..

Regarding claim 6, Nabeya et al. in view of Ngo et al. discloses the claimed invention as applied to claims 1, 2 and 3, except for the step of applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer.

Li et al. teach the step of applying hydrogen plasmas 38 to the surface of the insulation film 28 and the surface of the interconnection layer 36 (fig. 3, [0053]).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to applying hydrogen plasmas 38 to the surface of the

insulation film and the surface of the interconnection layer in Nabeya 's method, in order to improve the performance of the low-k dielectric in or over which the copper interconnect has been created by increasing the breakdown voltage of the low-k dielectric, resulting in improved Time Dependent Dielectric Breakdown (TDDB), removed the layer of CuO or Cu.sub.2O from the surface of a created copper interconnect, reduced the dielectric constant of the low-k dielectric in or over which the copper interconnect has been created by removing carbon from the low-k dielectric and by thereby making the low-k dielectric more porous, and prevented damage to the surface of the low-k dielectric in or over which the copper interconnect has been created. ([0055]-[0058])

Regarding claim 9, in the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed (Nabeya, fig, 1).

Regarding claim 13, Nabeya in view of Ngo disclose the claimed invention as applied to claims 1, 2 and 3, except for the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water, because it is commonly used to prevent undesirable reactions in the contact region, since it has been held to be within the

general skill of a worker in the art to select a known material on the basis of its suitability for the intended use.

Claim 5 is rejected under 35 U.S.C. 103 (a) as being unpatentable over Nabeya et al. (2004/0129569 A1) in view of Ngo et al. (6,146,988) and further in view of Li et al. (2004/0219795 A1).

Regarding claim 5, Nabeya et al. in view of Ngo et al. discloses the claimed invention as applied to claims 1- 2, except for the step of applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer.

Li et al. teach the step of applying hydrogen plasmas 38 to the surface of the insulation film 28 and the surface of the interconnection layer 36 (fig. 3, [0053]) .

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to applying hydrogen plasmas 38 to the surface of the insulation film and the surface of the interconnection layer in Nabeya 's method, in order to improve the performance of the low-k dielectric in or over which the copper interconnect has been created by increasing the breakdown voltage of the low-k dielectric, resulting in improved Time Dependent Dielectric Breakdown (TDDB), removed the layer of CuO or Cu.sub.2O from the surface of a created copper interconnect, reduced the dielectric constant of the low-k dielectric in or over which the copper interconnect has been created by removing carbon from the

low-k dielectric and by thereby making the low-k dielectric more porous, and prevented damage to the surface of the low-k dielectric in or over which the copper interconnect has been created. ([0055]-[0058]).

Claims 4, 10, 11, 14 and 15 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Nabeya et al. (2004/0129569 A1) in view of Li et al. (2004/0219795 A1).

Regarding claim 4. Nabeya et al. disclose the claimed invention as applied to claim 1, except for the step of applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer.

Li et al. teach the step of applying hydrogen plasmas 38 to the surface of the insulation film 28 and the surface of the interconnection layer 36 (fig. 3, [0053]).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to applying hydrogen plasmas 38 to the surface of the insulation film and the surface of the interconnection layer in Nabeya's method, in order to improve the performance of the low-k dielectric in or over which the copper interconnect has been created by increasing the breakdown voltage of the low-k dielectric, resulting in improved Time Dependent Dielectric Breakdown (TDDB), removed the layer of CuO or Cu.sub.2O from the surface of a created

copper interconnect, reduced the dielectric constant of the low-k dielectric in or over which the copper interconnect has been created by removing carbon from the low-k dielectric and by thereby making the low-k dielectric more porous, and prevented damage to the surface of the low-k dielectric in or over which the copper interconnect has been created. ([0055]-[0058])

Regarding claim 10, wherein in the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed. (Nabeya, fig. 1A).

Regarding claim 11, Nabeya in view of Li disclose the claimed invention as applied to claim 1, except for the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water, because it is commonly used to prevent undesirable reactions in the contact region, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use.

Regarding claim 14. Nabeya in view of Li disclose the claimed invention as applied to claims 1 and 4, except for the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water, because it is commonly used to prevent undesirable reactions in the contact region, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the special purpose.

Regarding claim 15, Nabeya in view of Li disclose the claimed invention as applied to claims 1 and 7, except for the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water, because it is commonly used to prevent undesirable reactions in the contact region, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the special application.

When responding to the office action, Applicants' are advice to provide the examiner with the line numbers and page numbers in the application and/or references cited to assist the examiner to locate the appropriate paragraphs.


A shortened statutory period for response to this action is set to expire 3 (three) months and 0 (zero) day from the day of this letter. Failure to respond within the period for response will cause the application to become abandoned (see M.P.E.P 710.02(b)).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dung A. Le whose telephone number is (571) 272-1784. The examiner can normally be reached on Monday-Tuesday and Thursday 6:00am- 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Nelms can be reached on (571) 272-1787. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9306 for regular communications and (703) 872-9306 for After Final communications.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DUNG A. LE 
Primary Examiner
Art Unit 2818